L-0572

OPERATING INSTRUCTIONS

TYPE 1219-A
UNIT PULSE AMPLIFIER

OCT. 1957

A GR UNIT INSTRUMENT

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manufacturers of
electronic apparatus
for science and industry

GENERAL RADIO COMPANY
CAMBRIDGE 39, MASSACHUSETTS, USA

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OPERATING AND MAINTENANCE
INSTRUCTIONS

TYPE 1219-A
UNIT PULSE AMPLIFIER

Form 909-A
October, 1957

GENERAL RADIO COMPANY
275 MASSACHUSETTS AVENUE
CAMBRIDGE 39 MASSACHUSETTS

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Printed in U.S.A.

SPECIFICATIONS

Output Pulse: The open-circuit output pulse voltage is between 10 and 250 volts and is the product of the combination of impedance and available current listed below.

(1) Impedance:

a. Positive pulse: 50, 75, 100, 150 ohms, all ±10%

b. Negative pulse: 50, 75, 100, 150, 200, 250, 300 ohms, all ±10%; 570 ohms ±20% designed to permit *maximum* output voltage.

(2) Output Current: This quantity depends upon the position of the duty-ratio selector switch and upon the duty ratio.

DUTY RATIO	OUTPUT CURRENT (ma)			
	POSITIVE PULSE		NEGATIVE PULSE	
	DR Sw 0.2	DR Sw 0.5	DR Sw 0.2	DR Sw 0.5
0.05	620 ±10%	350 ±15%	575 ±10%	330 ±15%
0.1	580 ±10%	325 ±15%	550 ±10%	300 ±15%
0.2	550 ±10%	300 ±15%	475 ±10%	275 ±15%
0.5	—	250 ±15%	—	225 ±15%

(3) Transition Times: The transition times depend on the transition times, magnitude, and polarity of the input pulse, as well as on the settings of the output impedance, polarity, and duty-ratio switches. These characteristics are summarized in the table below.

(4) Maximum Pulse Duration: The maximum duration of the pulse depends only on the tolerable ramp-off during the "on" period. If 10% is chosen, then the maximum "on" period for positive pulses is 10 m sec and for negative pulses 4 m sec; with the Type 1217-A, the maximum for negative pulses is 1 m sec, for positive pulses, 10 m sec.

(5) Pulse Shape: Overshoot less than 5% of amplitude on any output switch position.

(6) Noise: Hum on the output pulse less than 1% of pulse amplitude.

(7) Input Pulse: The maximum duration of the output pulse is to some extent determined by the input pulse voltage, and tolerable droop.

Input	MAXIMUM DURATION TO 10% DROOP	
	Positive Output	Negative Output
Negative 30 v	2000 μsec	4000 μsec
Negative 55 v	10,000	4000
Positive 10 v	10,000	6000

The droop is approximately linear, hence the maximum durations for 5% droop are ½ the above figures.

Input Impedance: Approximately 50 kilohms shunted by 30 μμf.

Power Supply: 105–125 volts, 50–60 cycles.
Input Power: 75 watts, full load, 115-volt line.
Dimensions: (Width) 10½ × (height) 5⅝ × (depth) 6¼ inches over-all. **Net Weight:** 8½ lbs.

INPUT PULSE			OUTPUT CHARACTERISTIC				
			DUTY RATIO Sw 0.2		DUTY RATIO Sw 0.5		
Polarity	Amplitude	Rise and Decay Time	Rise Time	Decay Time	Rise Time	Decay Time	OUTPUT Switch
Negative	30 v	2 mμsec	50 mμsec	30 mμsec	40 mμsec	20 mμsec	Negative, 50 Ω
			50	50	60	50	Negative, 50 Ω
Negative	30 v	50 mμsec	100	100	30	90	Negative, 570 Ω
			80	80	60	70	Positive, 50 Ω
			180	110	110	80	Positive, 150 Ω
			60	90	40	80	Negative, 50 Ω
Negative	50 v	1217-A	100	120	90	110	Negative, 570 Ω
		Pulser	90	120	70	100	Positive, 50 Ω
			180	160	120	130	Positive, 150 Ω
			60	240	40	160	Negative, 50 Ω
Positive	2.5 v	1217-A	110	240	80	160	Negative, 570 Ω
		Pulser	90	180	90	120	Positive, 50 Ω
(Minimum necessary drive)			180	240	130	160	Positive, 150 Ω
			50	80	40	60	Negative, 50 Ω
Positive	25 v	1217-A	90	110	100	100	Negative, 570 Ω
		Pulser	90	110	60	80	Positive, 50 Ω
(Pulse stretching 0.3 μsec)			180	150	110	110	Positive, 150 Ω

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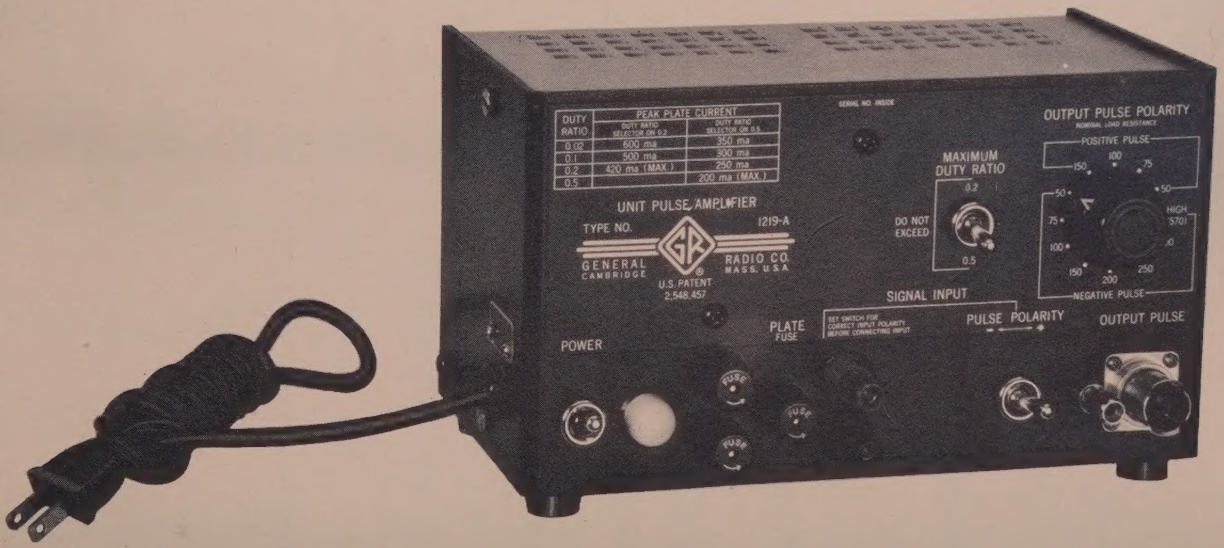


Figure 1. Panel View, Type 1219-A Unit Pulse Amplifier.

TYPE 1219-A
UNIT PULSE AMPLIFIER

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1219-A Unit Pulse Amplifier (Figure 1) is designed as a companion instrument to the Type 1217-A Unit Pulser, to produce pulses with many different characteristics of duration, duty ratio, and impedance level at higher power levels. In combination, the Unit Pulser and Unit Pulse Amplifier constitute a pulse generator approaching the wide range of durations and repetition rates characteristic of the Unit Pulser, but with power-output characteristics usually associated with more expensive and specialized pulse generators.

When driven by any available source of either positive or negative pulses, the Unit Pulse Amplifier produces pulses of current with magnitudes up to 600 ma. This pulse of current can drive internal loads to produce either positive or negative voltage pulses, or can be used to drive a load external to the instrument. The internal load resistors are chosen to terminate a wide variety of transmission lines in their characteristic impedances.

1.2 DESCRIPTION.

1.2.1 CONTROLS. The following controls are on the panel of the Type 1219-A Unit Pulse Amplifier:

Name	Type	Positions	Function
POWER	Toggle switch	on, off	Energizes instrument
MAXIMUM DUTY RATIO	Toggle switch	0.2, 0.5	Permits Unit Pulse Amplifier to produce square waves
OUTPUT PULSE POLARITY	Rotary selector switch	50, 75, 100, 150, (positive); 50, 75 100, 150, 200, 250, 300, HIGH (570)	Selects output impedance, polarity, and voltage amplitude
SIGNAL INPUT PULSE POLARITY	Toggle switch	-, +	Adapts instrument to operate on either input polarity

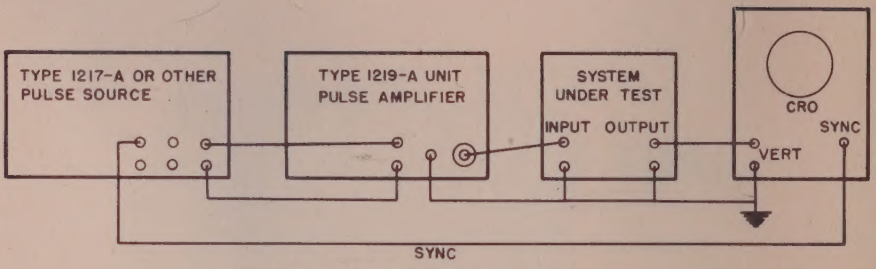


Figure 2. Interconnection Diagram.

1.2.2 CONNECTIONS. The following connections are on the panel and side of the Type 1219-A Unit Pulse Amplifier.

Name	Type	Function
OUTPUT PULSE	Coaxial connector, binding post	Connects instrument to external, driven system for either coaxial or banana-plug-type fittings
SIGNAL INPUT	Binding posts (2)	Connects driver to instrument
115 VOLT 50-60~	7-ft. cable with plug	Connects instrument to 115-volt source

1.3 AUXILIARY APPARATUS. Figure 2 illustrates a typical connection of the Unit Pulse Amplifier into an experimental system. This system consists of a pulse source, the Unit Pulse Amplifier, a load or system under test, and an indicator, such as a cathode-ray oscilloscope. (Note that the pulse-source ground is shown isolated from the Pulse Amplifier chassis ground. This is recommended to reduce noise on the input signal.) Interconnecting leads may be twisted pairs, single leads, or coaxial elements, depending upon the requirements of the experiment for bandwidth, overshoots, ringing, etc. (Refer to paragraph 3.2.)

Section 2

PRINCIPLES OF OPERATION

2.1 CIRCUIT.

2.1.1 GENERAL. When the Unit Pulse Amplifier is set to be driven by negative pulses, the instrument is a two-stage amplifier, consisting of a driver and a power amplifier. When set for positive pulse drive, an amplifier-inverter is added to the circuit to invert the input pulse. These stages, with input and output circuits and power supplies, constitute the instrument.

2.1.2 POWER AMPLIFIER STAGE. The power amplifier stage consists of two Type 5763 pentodes (V3 and V4) in parallel. Load resistances are connected in the plates of these tubes for negative output pulses. When positive output is desired, these pentodes are used as a cathode follower. The 12-position OUTPUT PULSE POLARITY switch is used to perform the following functions:

a. It selects either the plate circuit for negative-going pulses, or the cathode circuit for positive-going pulses, and connects the circuit selected to the OUTPUT terminal.
b. It grounds the positive side of the high-voltage supply for negative pulses, or the negative side for positive pulses, so that the output pulse always starts its transition from ground potential.
c. It selects load resistances as marked on panel.

The power supply for the plates and screens of the output stage produces 350 volts with a capacity of 100 ma (refer to paragraph 2.2). The screen voltage for this stage is reduced to 200 volts to reduce output plate current when the MAXIMUM DUTY RATIO switch is in the 0.5 position.

2.1.3 DRIVER STAGE. A second plate power supply provides a 260-volt potential for the driver and inverter stages. This supply is centered in voltage on the negative side of the 350-volt supply for the output stage; therefore, the cathode voltage of the driver stage (V2) is 130 volts negative with respect to that of the output stage. The driver is normally conducting with a plate-cathode potential of 70 volts. Thus, the conduction of the driver stage holds the output stage in the cutoff condition with a bias of 60 volts. A negative pulse in excess of 25 volts through the input coupling circuit will turn the driver stage off. When the driver stage is off, its plate voltage attempts to rise to equal the driver plate supply voltage (130 volts positive with respect to the cathode potential of the power amplifier). The power amplifier tubes are carried into the positive grid region and the pulse of output current is produced.

2.1.4 AMPLIFIER-PHASE-INVERTER STAGE. The amplifier stage permits a positive pulse to turn the driver stage off. When the Unit Pulse Amplifier is driven by a positive pulse in excess of 2.5 volts, the negative pulse needed to turn the driver off is produced. The INPUT POLARITY switch connects the input terminal to the grid of this tube, connects its plate circuit to the driver power supply, and transfers the driver grid coupling capacitor to its plate.

2.2 INPUT COUPLING CIRCUITS. The low input terminal is capacitively coupled via the network consisting of C8, C9, R38, and C17 to the negative side of the driver power supply. This coupling circuit permits referencing the input signal on the driver power supply, and eliminates power supply noise, which would be present as additional grid signal if the low terminal were grounded to the chassis. When the OUTPUT POLARITY switch is set from the negative to the positive pulse output positions, the chassis ground is changed from the positive to the negative side of the 350-volt supply, and a large voltage transient occurs. This transient is reduced in duration by a thyrite resistor, R37.

2.3 POWER SUPPLIES. Both the 350-volt and 260-volt supplies are of the full-wave doubler type, using selenium rectifiers with r-c filter sections. The heater supply for the four tubes is held at a safe d-c heater cathode potential by a voltage divider (R4, R5) on the driver supply.

The 350-volt supply is fused to protect the power amplifier in case of an error in operation where an excessive duty ratio occurs. The neon panel lamp is connected on the output side of the fuse. The lamp is extinguished to indicate a blown fuse.

Section 3

OPERATING PROCEDURE

3.1 GENERAL. Operation of the instrument requires only the proper positioning of various selector switches for input pulse polarity, duty ratio, desired output pulse polarity, and desired impedance level or amplitude. On the instrument panel is a table showing approximate available total current for the combination of internal source impedance and external load for various duty ratios. To determine the approximate output pulse voltage for all switch positions, multiply the total output impedance (internal resistance in parallel with any externally applied load) by the

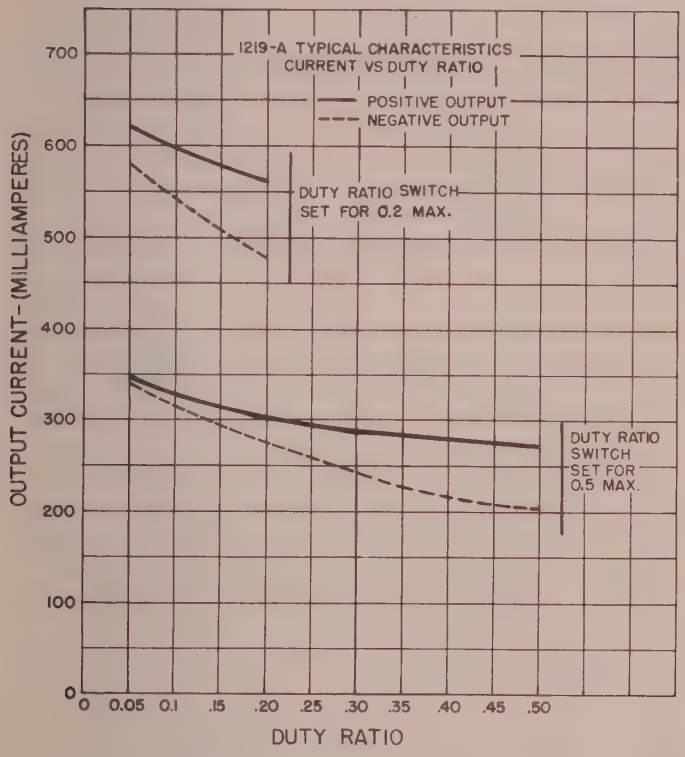


Figure 3. Effect of Duty Ratio on Output Current.

available current. (For a more complete tabulation of output current vs duty ratio, see Figure 3.)

3.2 TYPICAL OPERATING PROCEDURE. To obtain optimum performance, set up the system according to the following procedure:

a. Set up the system as illustrated in Figure 2.

b. Before turning on the Unit Pulse Amplifier, determine the input pulse amplitude, polarity, and the duty ratio of the source (by measurement if necessary). Check specifications to determine whether input amplitude is adequate.

c. Set the INPUT POLARITY and DUTY RATIO switches of Unit Pulse Amplifier to correspond to input pulse polarity and duty ratio. (If duty ratio is less than 0.2, the DUTY RATIO switch may be set in either position, depending on desired output amplitude.)

d. Set OUTPUT PULSE POLARITY switch as desired.

e. Turn the POWER switch on and observe the output pulse on the oscilloscope.

f. If a positive pulse is used to drive the Unit Pulse Amplifier, and it is somewhat in excess of the minimum amount necessary to turn the instrument on, a small hump may appear on the trailing edge of the output pulses. To remove this hump, reduce the input amplitude. (See Figure 5.)

3.3 OPERATING PRECAUTIONS.

3.3.1 DUTY RATIO. When the MAXIMUM DUTY RATIO switch is in the 0.2 position, do not exceed a 0.2 duty ratio, or a blown plate fuse will result.

3.3.2 NOISE AND JITTER. If a floating ground on the low input post is not used, some hum modulation and jitter will be observed on the output pulse. This effect is more pronounced with low-amplitude positive pulses than with negative pulses.

3.3.3 HEAT. At full load the Unit Pulse Amplifier dissipates 75 watts. Most of this heat must be carried away by air circulation over and through the unit. For this reason, do not stack Unit Pulse Amplifiers. In any permanent installation, make certain that there is an adequate supply of air at a maximum temperature of less than 40 C. To insure this, allow at least six inches clearance between top and bottom of the Unit Pulse Amplifier and other instruments.

3.4 OPERATING CHARACTERISTICS.

3.4.1 GENERAL. Since the Type 1219-A Unit Pulse Amplifier is capable of covering a wide range of pulse durations and repetition rates, the problem of obtaining optimum performance covers both low- and high-frequency effects. The following paragraphs divide these effects for easy reference as follows:

a. noise and jitter (paragraph 3.4.2)
b. transient response (ringing, spikes, etc) (paragraph 3.4.3),
c. ramp-off or slope on the flat top or bottom of the pulse, and the concomitant maximum pulse duration (paragraph 3.4.4), and
d. the effects of time delay through the Unit Pulse Amplifier (paragraph 3.4.5).

3.4.2 NOISE AND JITTER. Any noise due to hum or other disturbance on the input pulse will affect the output pulse, but since the amplifier tubes are on-off devices, the output is not generally a direct replica of the input. Thus hum present on the input pulse may well be converted to jitter on the trailing edge of the output pulse, etc. A small amount of hum modulating the amplitude of an input pulse will be completely removed in the output pulse. This is particularly true for negative input pulses.

Probably the most common source of noise or jitter on the output pulse is an incorrect connection of the input signal, so that a ground

exists between the low input terminal and chassis. Connecting the low input terminal of the Unit Pulse Amplifier to its chassis will add approximately five volts of 120-cycle power supply ripple to whatever input signal is applied.

3.4.3 TRANSIENT RESPONSE. Overshoots and ringing on the output pulse are usually caused by difficulties in the wiring connections between various units of the system, or by incorrect termination. In general, open wiring should be as short and direct as possible. Make sure that ground connections and fittings to oscilloscope, etc, are firmly tightened.

Overshoot effects are usually more pronounced as the source impedance is lowered, and are often very difficult to track down and eliminate. This is particularly true where wiring is connected directly to oscilloscope deflection plates, so that it is difficult to establish the most direct ground lead. Some experimenting is normally necessary to minimize high-frequency ringing for each new system setup.

One type of transient difficulty can be caused by excessive positive pulse drive. With a positive input pulse considerably greater than 10 volts a small hump (5% of amplitude) will appear on the trailing edge of the output pulse. To eliminate this hump, reduce the input amplitude to the correct value. Overdrive causes the output pulse to be stretched by as much as 0.4 μsec; reduction of input amplitude eliminates this stretching. (See Figure 5.)

3.4.4 RAMP-OFF - MAXIMUM PULSE DURATION. During the pulse "on" time the output stage is conducting heavily and discharging the output filter capacitor of its power supply. This decrease in power-supply voltage reduces pulse amplitude. The dash-line curves in Figure 4 show the droop in percent as a function of the duration of the pulse. If five percent is chosen as the tolerable droop, the maximum pulse duration due to this effect is 2000 μsec for negative output pulses and 5000 μsec for positive output pulses. The effect of falling power-supply voltage on the output pulse is reduced by the cathode-follower connection for the output tubes. The maximum pulse duration set by this effect is limited only by the droop that is tolerable.

The solid curves of Figure 4 show, in addition to the effect discussed above, a further droop condition that can be caused by low input pulse voltage. If the negative input pulse amplitude is in excess of 30 volts, the power-supply droop effect predominates, but if it is lowered to, say, 25 volts, then the input coupling capacitor to the driver stage will discharge enough to let the driver stage return to conduction before the full 10-percent droop occurs, and the output pulse will begin to fall rapidly in amplitude. Since this effect is due to the discharge of the input coupling capacitor, it is obvious that any capacitor external to the Unit Pulse Amplifier will decrease the maximum duration for a given input pulse amplitude.

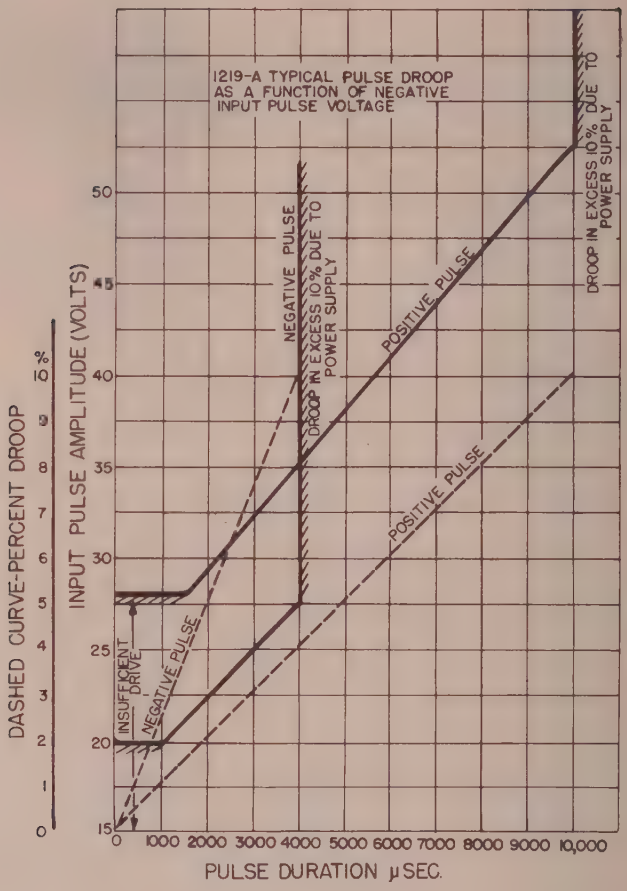


Figure 4. Output Pulse Characteristics as a Function of Maximum Permissible Pulse Duration.

To summarize, droop, or a rapid termination of an output pulse of long duration, is a combination of these effects:

a. discharge of internal power supply,
b. insufficient driving voltage, and
c. poor low-frequency response due to an external coupling capacitor.

Effects a and b, characteristic of the Type 1219-A Unit Pulse Amplifier, are summarized graphically in Figure 4.

NOTE

The coupling circuit and available amplitude for positive input pulses will permit maximum duration for 10-percent droop (Figure 4) to be realized with 4 volts on the input.

Input Neg. 50v 0.05μsec
Output Neg. 25v 50Ω 0.05μsec

Input Neg. 50v 0.05μsec
Output Pos. 20v 50Ω 0.05μsec

Input Pos. 50v 0.05μsec
Output Pos. 30v 50Ω 0.4μsec
(Note stretching caused by overdrive)

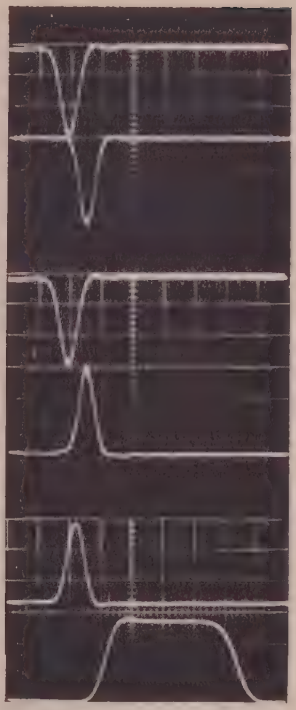


Figure 5. Time Delay and Overdrive Effects.

3.4.5 TIME DELAY.

3.4.5.1 Negative Input Pulse. About 0.05 μsec is required after the application of a pulse at the input terminals before the output pulse begins to rise. This time delay is clearly shown in Figure 5. The effect is due to the fact that a definite period of time is required to bring the output stage from its quiescent point in cutoff up to full plate current. The effect, as shown in Figure 5, is about the same with a negative driving pulse for either positive or negative output pulses.

3.4.5.2 Positive Input Pulse. When a positive input pulse is used, the time delay is increased by the presence of the additional stage. The delay of 0.12 μsec is also shown in Figure 5. In addition to this effect, an excessive driving amplitude will "stretch" the output pulse by as much as 0.4 μsec. This effect, due to recovery time constant in the grid of the driver, may be reduced by reduction of the input amplitude to the driver to prevent the excessive swing.

3.4.6 FACTORS AFFECTING RISE-AND-FALL TIMES. As with any amplifier, the rise-and-fall times at the output terminals depend upon the in-

put transition times. But, since the Unit Pulse Amplifier includes class "c" amplifier stages, the direct relationships set by the bandwidth for linear circuits do not apply. It is possible, for example, to improve the rise time of an input signal by overdriving. As shown in the specifications, the intrinsic rise-and-fall time at the output terminals for a negative input pulse is in the order of 0.04 μsec for the 50-ohm output positions. This figure increases in value for positive input pulses, positive output pulses, and increasing output impedances. It decreases in value for all input-output settings when the MAXIMUM DUTY RATIO switch is in the 0.5 position. Since the amplitude, polarity, and rise times of the input signal determine the output transition times, it is not possible to predict the performance figures for all possible systems.

Section 4

SERVICE AND MAINTENANCE

4.1 GENERAL. This service information, together with the information given in other sections, should enable the user to locate and correct ordinary difficulties resulting from normal use.

Major service problems should be referred to our Service Department, which will cooperate as much as possible by furnishing information and instructions as well as by supplying any replacement parts needed. When notifying our Service Department of any difficulties in operation or service, specify the serial and type number of the instrument. Also give a complete report of the trouble encountered and steps taken to eliminate the trouble.

Before returning an instrument or parts for repair, please write to our Service Department, requesting a Returned Material Tag, which includes shipping instructions. Use of this tag will insure proper handling and identification. A purchase order covering material returned for repair should also be forwarded to avoid unnecessary delay.

4.2 SERVICE.

4.2.1 GENERAL. A complete table of voltage and resistance measurements appears at the end of this Section. Typical waveforms in a properly operating instrument are shown in Figure 8. It should not usually be necessary to resort to a complete system test to isolate and remedy normally encountered difficulties such as those listed in paragraph 4.2.3.

4.2.2 OPENING THE INSTRUMENT.

WARNING

Always disconnect power before opening the instrument case. The total power supply potential is 450 volts.

To open the instrument case:

a. Disconnect power cord from outlet.
b. Loosen the two thumb screws on the right-hand end of the instrument.
c. Slide the cover off.

To gain access to components inside the shelf:

d. Remove the top thumb screw on the right-hand end, and the top screw on the left-hand end.
e. Using an Allen wrench, loosen the two set screws in the PULSE POLARITY switch shaft collar nearest the panel. Pull out knob from the front.
f. Carefully swing the panel down from top until it strikes the limit screw. Check that no wiring is entangled so as to limit travel.

NOTE

No electrical connections are broken when the shelf is opened; thus, when the PULSE POLARITY knob and the power cord are replaced, the instrument is fully operative.

4.2.3 TROUBLE-SHOOTING PROCEDURE. The following table outlines the most common troubles and their remedies.

TROUBLE	REMEDY
Instrument inoperative	
Pilot lamp extinguished	Check the three fuses, starting with plate fuse. Check power supply frequency and voltage. Check the main, 350-volt supply.
Instrument inoperative for positive input polarity only	Check V1 and its components, R10, R11, and C10.
Instrument inoperative when DUTY RATIO switch is in 0.5 position only	Check R15 and C14.

TROUBLE	REMEDY
Instrument inoperative (cont)	
Instrument inoperative for all switch settings	Check V2, V3, V4. Check driver power supply voltage
Output pulse defective	
Low amplitude	Check V3, V4.
Top of pulse not flat	See paragraph 3.4.4. Input pulse might be of too great duration. Check C6 and C7 by substitution.
Large spike on leading edge	Increase driving amplitude. Check V1.
Small hump on trailing edge with INPUT POLARITY set at +	Decrease driving amplitude.
Jitter on trailing edge, hum on top of pulse	Make sure driver ground is not connected to pulse amplifier chassis ground. Check for excess hum on input pulse. Check that resistance of thyrite resistor R8 is 500 kilohms ±50% with 5 volts impressed. (Use Simpson Model 260 multimeter or equivalent.) Measure hum on driver supply (between cathode pins 3 and 8 of V2 and the top end of R14). Hum should be 0.5 volt peak to peak or less.

D-C VOLTAGE AND RESISTANCE CHART

TUBE (TYPE)	OUTPUT POLARITY S4	PLATE			SCREEN			GRID			CATHODE		
		PIN	VOLTS TO GND	RES TO GND*	PIN	VOLTS TO GND	RES TO GND*	PIN	VOLTS TO GND	RES TO GND*	PIN	VOLTS TO GND	RES TO GND*
V1 (6J6)	+50	1,2	+50 (+45)	8.2k				5,6	-114 (-114)	180k	7	-110 (-110)	510
V2 (12AU7)	+50	1	-55 (-34)	4.0k				2	-102 (-123)	33k	3	-105 (-108)	0
	+50	6	-55 (-34)	4.0k				7	-102 (-123)	33k	8	-105 (-108)	0
V3 (5763)	+50	1	350 (280)	0	6	200 (113)	15k †	8,9	-55 (-34)	4.0k	7	0 (5.0)	56**
V4 (5763)	+75	1	350 (280)	0	6	200 (117)	15k †	8,9	-55 (-32)	4.0k	7	0 (7.0)	92**
	+100	1	350 (280)	0	6	200 (119)	15k †	8,9	-55 (-30)	4.0k	7	0 (8.6)	128**
	+150	1	350 (280)	0	6	200 (123)	15k †	8,9	-55 (-26)	4.0k	7	0 (13.0)	253**
	-50	1	0 (-4.0)	50**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-75	1	0 (-5.5)	77**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-100	1	0 (-6.7)	101**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-150	1	0 (-9.0)	157**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-200	1	0 (-11.0)	208**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-250	1	0 (-12.5)	259**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-300	1	0 (-14.0)	310**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0
	-570	1	0 (-19.3)	610**	6	-160 (-170)	15k †	8,9	-400 (-306)	4.0k	7	-350 (-280)	0

CONDITIONS: Voltages are indicated for both SIGNAL and NO SIGNAL operation. NO SIGNAL: SIGNAL INPUT switch S2 = +, DUTY RATIO switch S3 = 0.5, no output connection, no external load. SIGNAL: Use voltages in parentheses, which refer to square-wave input 5kc, 3v peak to peak. Line = 115v. Power input (no signal) = 45w.

NOTES: * - All resistances are in ohms, except as otherwise indicated by k (kilohms). Resistance measurements are to be made with all sections of C3 and C7 shorted.

** - Can also be measured at output terminals.

† - Resistance to ground is zero when DUTY RATIO switch S3 = 0.2.

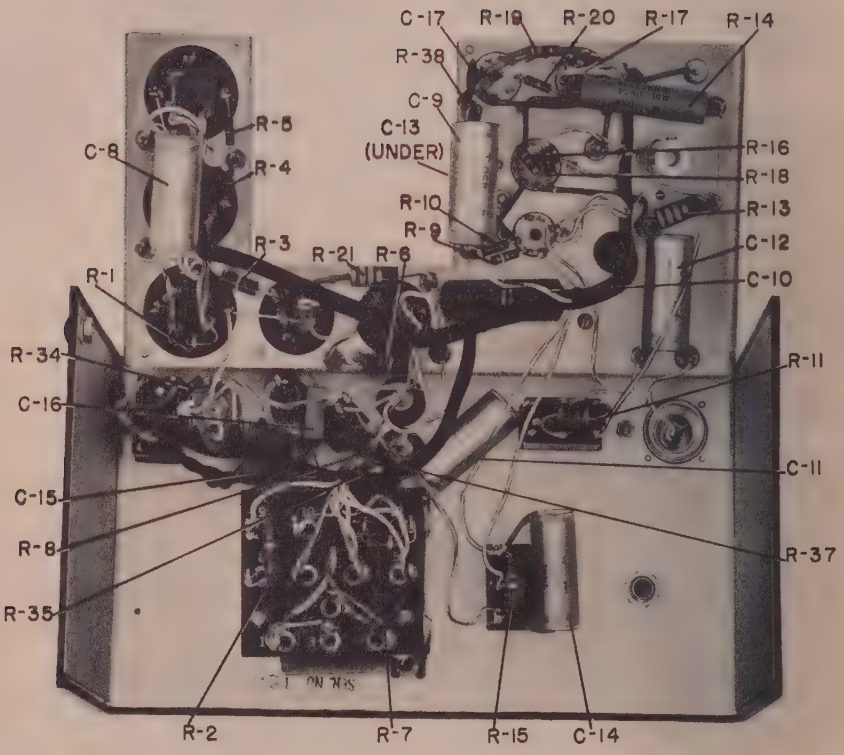


Figure 6. Bottom Interior View.

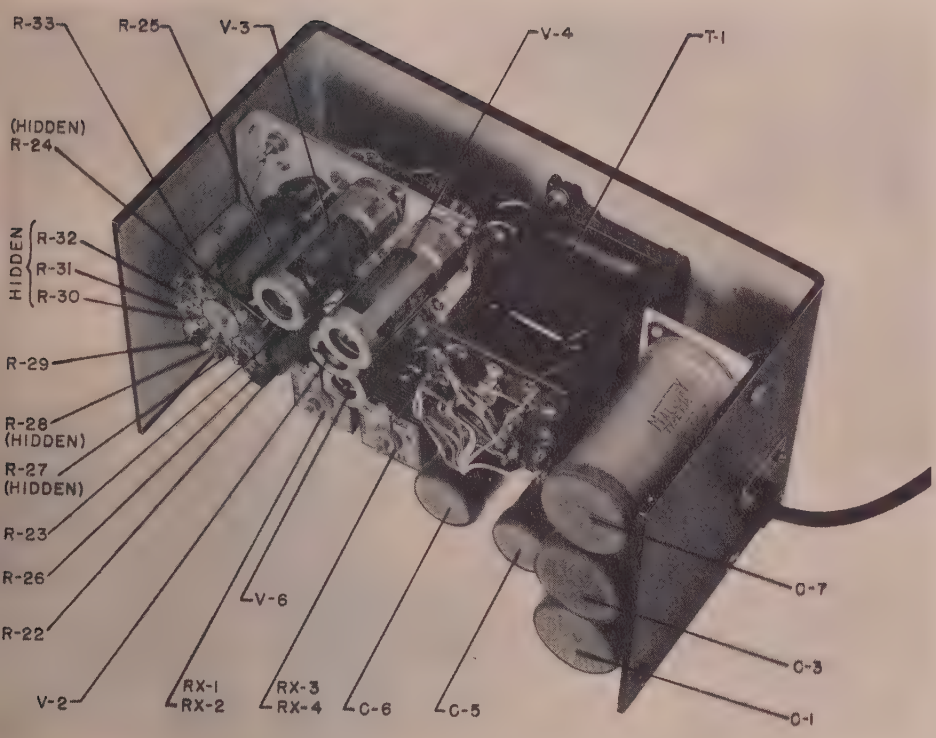


Figure 7. Top Interior View.

Section 5

PARTS LIST

					GR NO. (Note A)
RESISTORS (Note B)	R1	100	±10%	1w	REC-30BF
	R2	10	±10%	1w	REC-30BF
	R3	100	±10%	1w	REC-30BF
	R4	56k	± 5%	1/2w	REC-20BF
	R5	56k	± 5%	1/2w	REC-20BF
	R6	100	±10%	2w	REC-41BF
	R7	10	±10%	1w	REC-30BF
	R8	100k	± 5%	1/2w	REC-20BF
	R9	180k	± 5%	1/2w	REC-20BF
	R10	510	± 5%	1/2w	REC-20BF
	R11	8.2k	± 5%	2w	REC-41BF
	R13	33k	± 5%	2w	REC-41BF
	R14	4k	± 5%	10w	REPO-42-2
	R15	27k	± 5%	2w	REC-41BF
	R16	47	± 5%	1/2w	REC-20BF
	R17	100	± 5%	1/2w	REC-20BF
	R18	100	± 5%	1/2w	REC-20BF
	R19	47	± 5%	1/2w	REC-20BF
	R20	100	± 5%	1/2w	REC-20BF
	R21	33k	± 5%	2w	REC-41BF
	R22	125	± 5%	5w	REPO-42
	R23	36	± 5%	2w	REC-42BF
	R24	36	± 5%	2w	REC-41BF
	R25	56	± 5%	5w	REPO-42
	R26	50	± 5%	5w	REPO-42
	R27	27	± 5%	2w	REC-41BF
	R28	24	± 5%	2w	REC-41BF
	R29	56	± 5%	5w	REPO-42
	R30	51	± 5%	2w	REC-41BF
	R31	51	± 5%	2w	REC-41BF
	R32	51	± 5%	2w	REC-41BF
	R33	300	± 5%	5w	REPO-42
	R34	1M	± 5%	1/2w	REC-20BF
	R35	100k	± 5%	1/2w	REC-20BF
	R37	Thyrite			REU-8
	R38	330	± 5%	1/2w	REC-20BF
(Note C)	C1A	90			
	C1B	30	+100% -10%	300dcwv	COE-52
	C1C	30			
	C3A	50			
	C3B	25	+100% -10%	450dcwv	COE-10
	C3C	25			

				GR NO. (Note A)
CAPACITORS (Note C)	C5A	30	+100% -10% 150dcwv	COE-28
	C5B	30		
	C6A	25	+100% -10% 200dcwv	COE-51
	C6B	25		
	C7A	50		
	C7B	25	+100% -10% 450dcwv	COE-10
	C7C	25		
	C8	16	+100% -10% 150dcwv	COE-4
	C9	4	+100% -10% 450dcwv	COE-32
	C10	0.1	±10% 600dcwv	COL-71
	C11	4	+100% -10% 450dcwv	COE-32
	C12	16	+100% -10% 150dcwv	COE-4
	C13	50	+100% -10% 15dcwv	COE-47
	C14	10	+100% -10% 250dcwv	COE-33
	C15	0.01	300dcwv	COM-35
	C16	0.01	300dcwv	COM-35
	C17	0.0047	+100% -0% 500dcwv	COC-62
MISCELLANEOUS	F1	Fuse (for 115v), 1 amp Slo-Blo 3AG		FUF-1
	F1	Fuse (for 230v), 0.5 amp Slo-Blo 3AG		FUF-1
	F2	Fuse (for 115v), 1 amp Slo-Blo 3AG		FUF-1
	F2	Fuse (for 230v), 0.5 amp Slo-Blo 3AG		FUF-1
	F3	Fuse, 0.1 amp Slo-Blo 3AG		FUF-1
	J1	Binding Post, input, red		BP-5R
	J2	Binding Post, input, black		BP-5B
	J3	Binding Post, output		874-404
	J4	Binding Post, ground		BP-10
	P1	Pilot Light, 70v		NE-51
	PL1	Power Cord		CAP-1-2
	RX1	Rectifier		2RE-11
	RX2	Rectifier		2RE-11
	RX3	Rectifier		2RE-11
	RX4	Rectifier		2RE-11
	S1	Switch, power		SWT-333NP
	S2	Switch, pulse polarity		SWT-335NP
	S3	Switch, duty ratio		SWT-320NP
	S4	Switch, pulse output		SWRW-109
	T1	Transformer, power		485-483

NOTES

(A) Type designations for resistors and capacitors are as follows:

COC - Capacitor, ceramic
COE - Capacitor, electrolytic
COL - Capacitor, oil
COM - Capacitor, mica

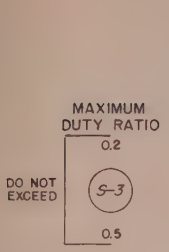
REC - Resistor, fixed, composition
REPO - Resistor, fixed, power
REU - Resistor, fixed, unclassified

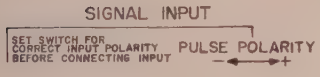
(B) All resistances are in ohms, except as otherwise indicated by k (kilohms) or M (megohms).

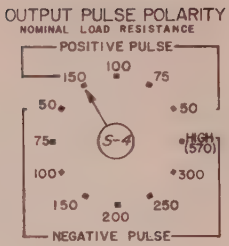
(C) All capacitances are in microfarads.

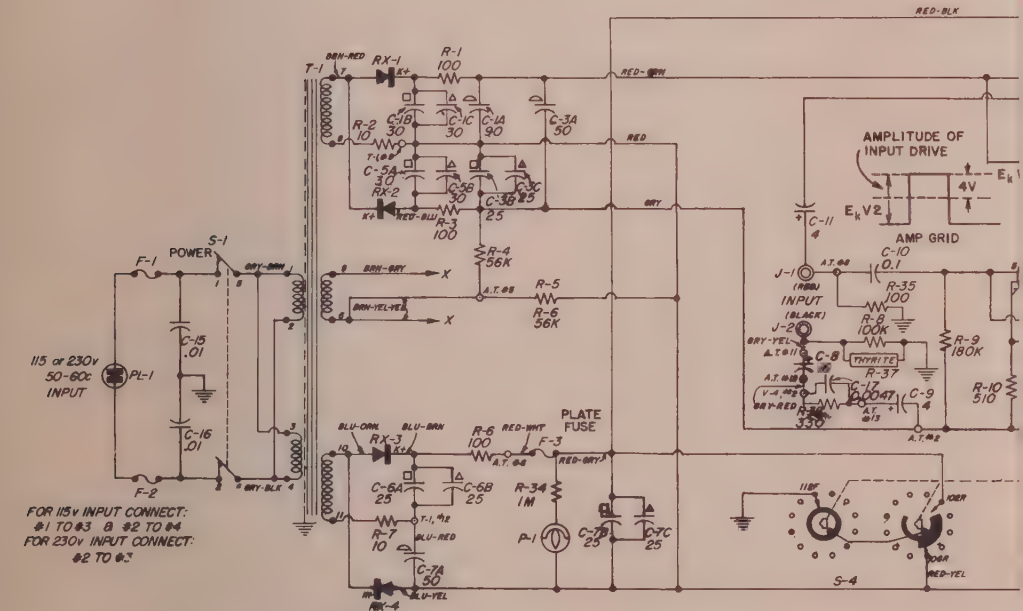
PANEL ENGRAVING

DUTY RATIO	PEAK PLATE CURRENT	
	DUTY RATIO SELECTOR ON 0.2	DUTY RATIO SELECTOR ON 0.5
0.02	600 ma	350 ma
0.1	500 ma	300 ma
0.2	420 ma (MAX)	250 ma
0.5		200 ma (MAX)





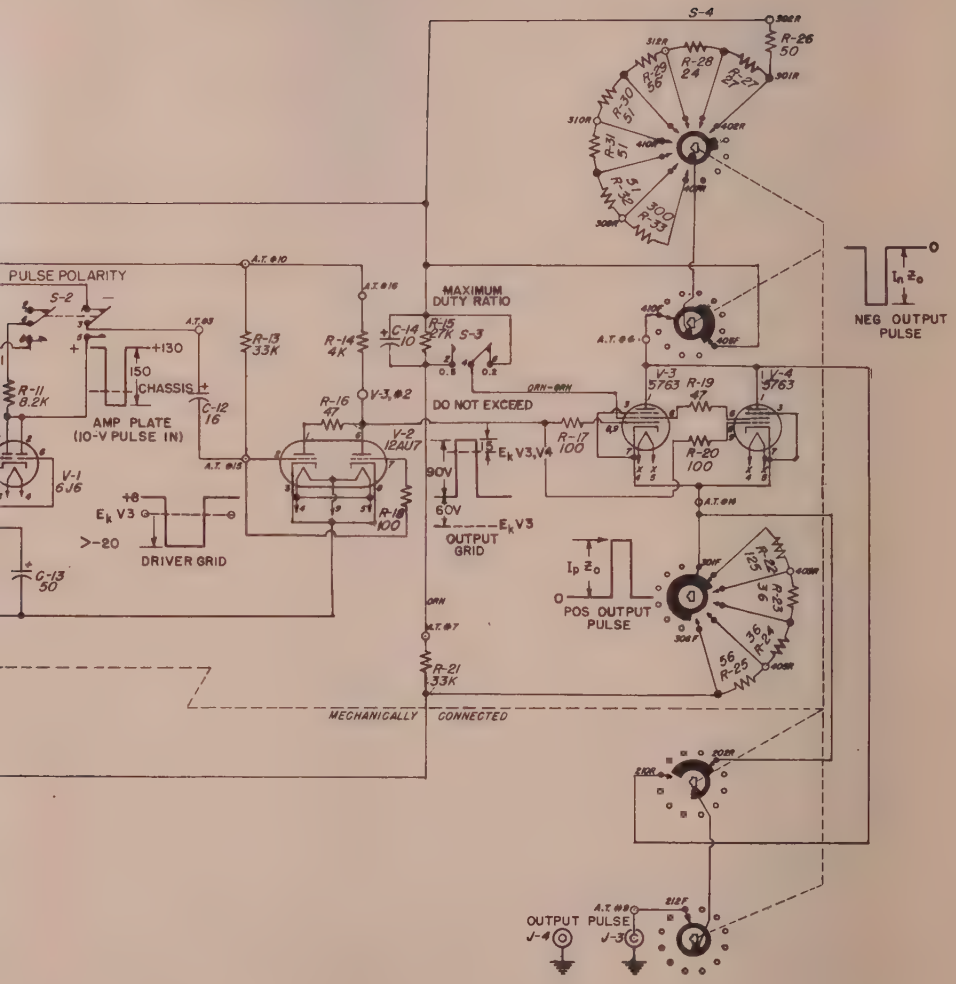




NOTE: RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED.
K = 1000 OHMS M = 1 MEGOHM

CAPACITANCE IN MICROFARADS UNLESS OTHERWISE SPECIFIED

Figure 8. Schematic Wiring Diagram for



Type 1219-A Unit Pulse Amplifier.

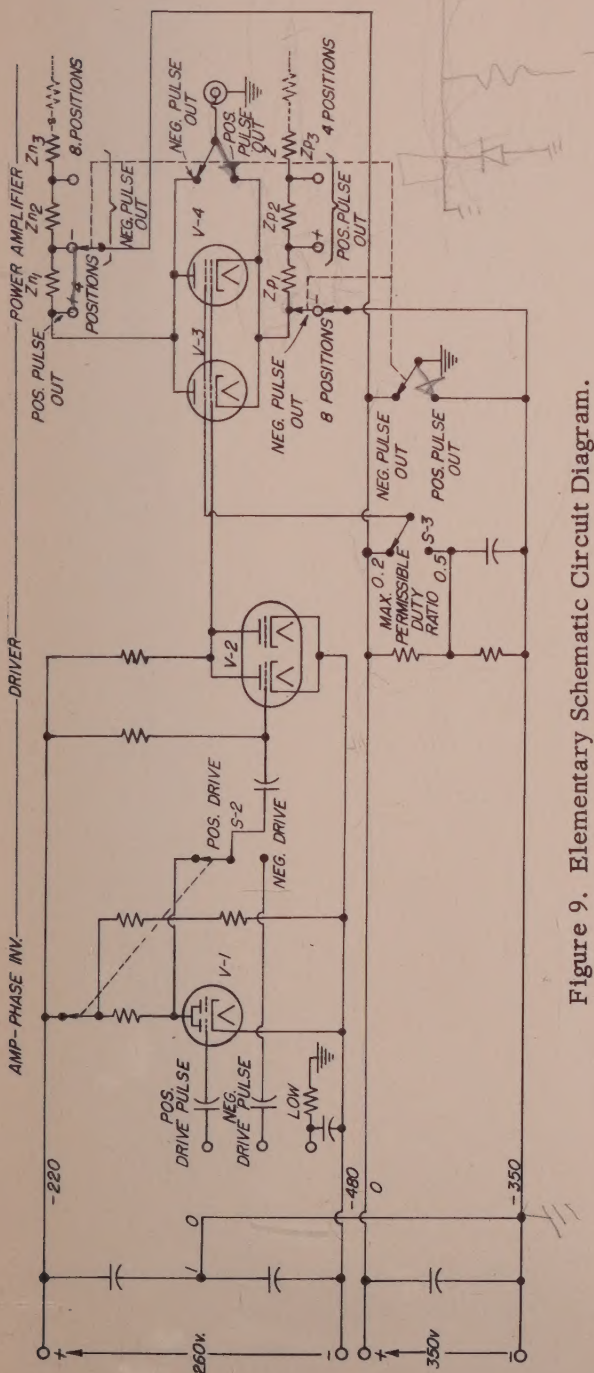


Figure 9. Elementary Schematic Circuit Diagram.

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